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ABSTRACT

This booklet is intended to help mainstreamed mentally retarded, emotionally disturbed, or learning disabled high school students acquire a basic understanding of the responsibilities and working conditions of maintenance mechanics and to practice basic math skills necessary in the occupation. The first section provides a brief introduction to the occupation by focusing upon those job tasks of a maintenance mechanic with which the student is likely to be familiar. The next two sections deal with the work environment of the typical maintenance mechanic and the training, education, and experience needed for the occupation. Exercises addressing basic math skills used by maintenance mechanics are provided. Various suggestions are listed for students interested in further exploring the occupation of maintenance mechanic. A glossary and answer sheet conclude the booklet. (MN)

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MATH on the job

Maintenance Mechanic

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MATH ON THE JOB:

MAINTENANCE MECHANIC

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MATH on the job

Maintenance Mechanic

In this booklet, you can--

- find out what a maintenance mechanic does
- see how a maintenance mechanic uses math
- get a chance to use math as a maintenance mechanic
- find out the types of things a maintenance mechanic needs to know
- find out what courses, training, and experience you need to become a maintenance mechanic

SPECIAL WORDS USED IN THIS BOOKLET

Workers in many jobs use special words or special meanings for words. Learning these words helps you to learn about a job.

You will find some of these special words in this booklet. When these words, and some hard words, are used for the first time, they are followed by one or more **asterisks.*** These words are also in the **glossary**** at the back of the booklet.

DEFINITIONS

*An asterisk (*) is a symbol that tells you to look at the bottom of the page for the meaning, or definition, of the word.

**A glossary is a list of words with their meanings.

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HAVE YOU EVER...

- helped someone repair an electric motor or pump?
- tried to figure out why a machine, such as a lawnmower, was not working properly?
- watched someone repair a complicated piece of machinery?
- oiled a machine so that it would work properly?

If you have, then you have some idea about the work of a maintenance mechanic. This booklet will help you learn more about the work of a maintenance mechanic and how math is important to do the job.

WHAT DOES A MAINTENANCE MECHANIC DO?

A maintenance mechanic inspects, maintains, repairs, and adjusts machinery and equipment. When a machine breaks down in a plant or factory, it is the maintenance mechanic's job to get the machine working as quickly as possible. How does a maintenance mechanic do this? The maintenance mechanic--

- reads blueprints* to see how the machine is built
- examines broken-down machines to figure out what is wrong with them
- repairs or replaces broken or worn parts
- oils and greases the machinery
- cleans parts on the machinery
- inspects and operates the machinery to make sure it is working correctly
- keeps complete and up-to-date records on the maintenance work

DEFINITION

*A blueprint is a drawing that shows how something is to be made or put together.

A maintenance mechanic uses math on the job every day. The mechanic--

- reads and writes whole numbers, decimals, and fractions
- adds, subtracts, multiplies, and divides
- uses measuring instruments
- changes English measurements to metric units
- figures out ratios and proportions

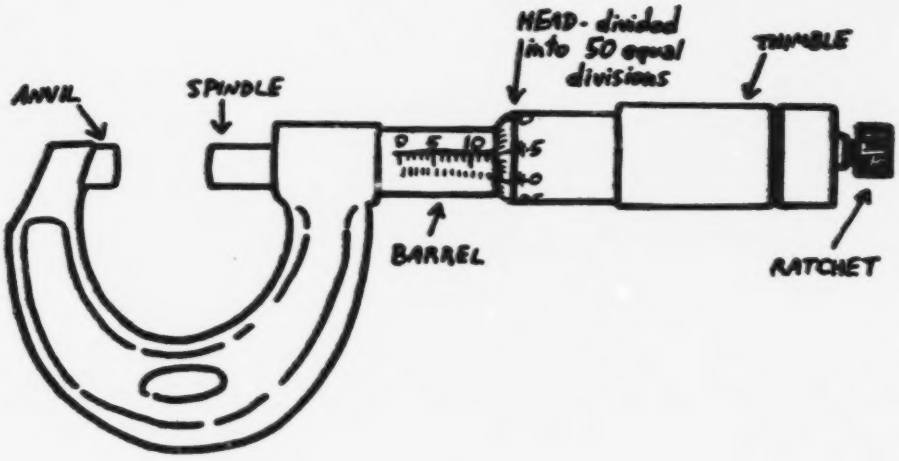
The mechanic uses these skills to--

- measure machine and equipment parts
- figure out the amount of wear on the parts
- figure out the amount of time spent working on machinery
- read gauges, dials, and meters
- set machines at the correct operating speed or pressure
- figure out ratios to determine gear or pulley sizes
- measure fasteners or bolts

A maintenance mechanic uses math to read measuring instruments.

EXAMPLE

A maintenance mechanic uses special measuring instruments, such as micrometers. A metric micrometer measures items to the nearest hundredth of a millimeter. The basic parts of a micrometer are labeled in the figure below.



To measure a small object, place it between the anvil and the spindle. Turn the thimble until the object fits snugly.

The micrometer has markings for whole millimeters (the upper set of marks on the barrel). The lower set of marks on the barrel are for half millimeters. The marks on the head indicate .01 millimeter.

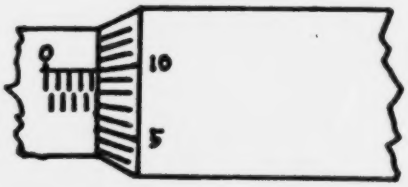
To read a metric micrometer, you--

Step 1. Find the whole millimeters in the measurement by counting the number of upper marks on the barrel to the left of the head.

Step 2. Find the decimal part of the measurement by reading the marking on the head that is most nearly in line with the center line on the barrel. Multiply this reading by .01. If the head is on or immediately to the right of a half millimeter marking, add .50 millimeter to the reading on the head.

Step 3. To get the total reading, add the numbers from Step 1 and Step 2.

What is the measurement on the metric micrometer below?



4.00 + .10 + .50 = 4.60

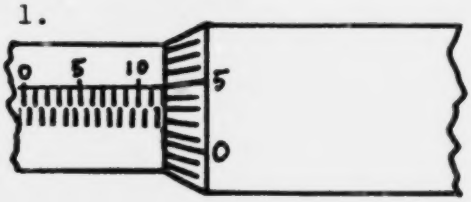
The total measurement is 4.60.

NOW YOU TRY IT

Practice Exercise A

What is the measurement on each metric micrometer below?

1.



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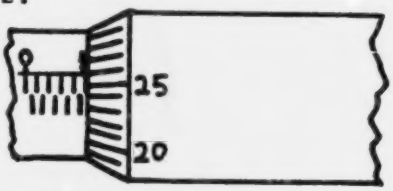

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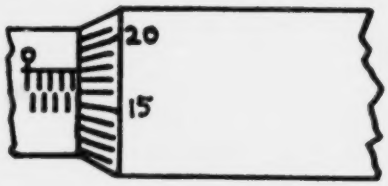

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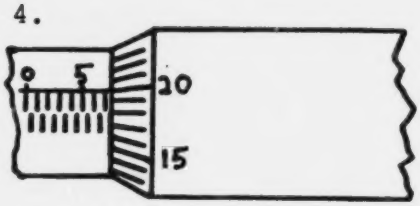


A maintenance mechanic uses math to change from one system of measurement to another.

EXAMPLE

A conversion table for English measurement to metric measurements of length is given below.

English		Metric
1	in.	= 2.54 centimeters (cm)
1	ft.	= 30.5 centimeters (cm)
1	yd.	= 91.4 centimeters (cm)
1	mile	= 1610 meters (m)
1	mile	= 1.61 kilometers (km)
.0394	in.	= 1 millimeter (mm)
.394	in.	= 1 centimeter (cm)
39.4	in.	= 1 meter (m)
3.28	ft.	= 1 meter (m)
1.09	yd.	= 1 meter (m)
.621	mile	= 1 kilometer (km)

How many centimeters is 17 inches?

Step 1. Find in the table the metric conversion for the English measurement. For this example, the metric conversion is 2.54 cm = 1 inch.

Step 2. Multiply the metric conversion by the English measurement:

2.54 cm x 17 in. = 43.18

So 17 inches is 43.18 centimeters.

NOW YOU TRY IT

Practice Exercise B

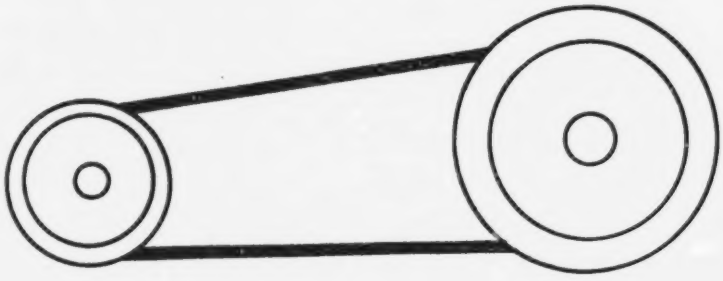
Use the conversion table in the example above to complete the following.

5. 48 cm = ? in.
6. 6 yd. = ? cm
7. 5.2 in. = ? mm
8. 26 ft. = ? m
9. 102 m = ? ft.
10. 83 mm = ? in.

A maintanence mechanic uses math to figure the diameter and turning speed of pulleys.

EXAMPLE

A maintenance mechanic must know how machines work. A pulley is a common machine.



Let's assume that the diameter of pulley A is 10 inches and the diameter of pulley B is 20 inches. How many revolutions per minutes (rpm) does pulley B turn if pulley A turns at 90 rpm?

The following formula shows the relationship between diameter and rpm of the two pulleys.

$$\frac{\text{Diameter of A}}{\text{Diameter of B}} = \frac{\text{rpm of B}}{\text{rpm of A}}$$

When you substitute the values for pulleys A and B, the formula looks like this:

$$\frac{10}{20} = \frac{x}{90}$$

To find the value of x, multiply the diameter of pulley of A by the rpm of pulley A. Then divide the result by the diameter of B. For this example, your calculation would look like this:

$$10 \times 90 = 900$$
$$900 \div 20 = 45$$

Pulley B turns at 45 rpm.

NOW YOU TRY IT

Practice Exercise C

11. A small pulley is 12 inches in diameter and a larger one is 20 inches in diameter. At what rpm does the larger pulley turn if the smaller one turns at 800 rpm?

12. A pulley 28 inches in diameter turns at 85 rpm. It drives a smaller pulley at 420 rpm. What is the diameter of the smaller pulley?

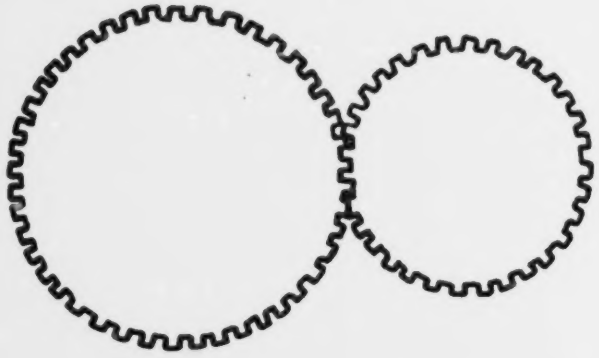
Copy and complete the table below.

	Pulley A		Pulley B	
	Diameter	RPM	Diameter	RPM
13.	20 in.	82	40 in.	?
14.	12 in.	?	18 in.	96
15.	40 in.	120	50 in.	?
16.	? in.	25	10 in.	50
17.	15 in.	180	?	300
18.	? in.	95	15 in.	225

A maintenance mechanic uses math to figure out the relationship between gears.

EXAMPLE

Gears are commonly used in machines.



Let's assume that gear A has 44 teeth and gear B has 32 teeth. At what rpm does gear B turn if gear A turns at 36 rpm?

The following formula shows the relationship between the number of teeth and rpm of two gears.

$$\frac{\text{Number of teeth in A}}{\text{Number of teeth in B}} = \frac{\text{rpm of B}}{\text{rpm of A}}$$

When you substitute the values for gears A and B, the formula looks like this:

$$\frac{44}{32} = \frac{x}{36}$$

To find the value of x, multiply the number of teeth for gear A by the rpm for gear A. Then divide the result by the number of teeth for gear B. For this example, your calculations should look like this:

$$44 \times 36 = 1{,}584$$
$$1{,}584 \div 32 = 49.5$$

Gear B turns at 49.5 rpm.

Practice Exercise D

19. A large gear has 75 teeth and a small gear has 25 teeth. At what rpm does the small gear turn if the large gear turns at 32 rpm?

20. A large gear with 280 teeth turns at 600 rpm. It turns a small gear at 1700 rpm. How many teeth does the small gear have?

Copy and complete the table below.

	Gear A		Gear B	
	Number of Teeth	rpm	Number of Teeth	rpm
21.	10	90	?	45
22.	124	?	67	149
23.	472	64.2	793	?
24.	?	120	40	90
25.	10	75	?	15

WHERE DOES A MAINTENANCE MECHANIC WORK?

As a maintenance mechanic, you will probably work for a manufacturer. You might work in a--

- machine shop
- printing plant
- oil refinery
- garment-making shop
- automobile manufacturing plant
- aircraft manufacturing plant
- food processing plant

Would you like to work in any of these places?

As a maintenance mechanic, you will have a supervisor. The supervisor will--

- tell you what to do
- check to see that the work is done correctly
- help solve any problems

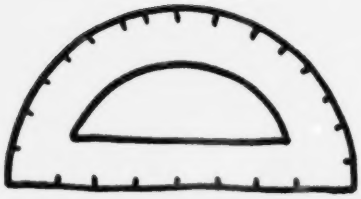
The work of a maintenance mechanic can be dirty and tiring. You may have to work in stooped or cramped positions. You may have to lift heavy objects. You may have to climb on ladders to reach machinery located above the floor.

A maintenance mechanic uses many different tools and types of equipment. A mechanic uses--

- hand tools such as hammers, pliers, wrenches, saws, clamps, and screwdrivers
- power tools such as drills, saws, and grinders
- pressure gauges to check air and fluid pressure
- welding equipment to join broken metal parts or to cut metal
- measuring instruments such as **micrometers***, rulers, and **calipers**** to measure thickness, height, and diameter

Caliper

Scale



Protractor

DEFINITIONS

*__Micrometers__ are instruments used to make small, precise measurements.

**__Calipers__ are instruments with two legs or pieces that can be adjusted to determine thickness, diameter, and distance between surfaces.

IF YOU ARE INTERESTED IN

THE WORK OF A MAINTENANCE MECHANIC

AND WOULD LIKE TO KNOW MORE,

READ ON

WHAT TRAINING, EDUCATION, AND EXPERIENCE DO YOU NEED TO BECOME A MAINTENANCE MECHANIC?

Would you like to be a maintenance mechanic? If you would, there are some things you should know. You should know how to--

- read blueprints
- use special tools
- use measuring instruments
- use shop mathematics

You can begin training for a job as a maintenance mechanic in high school. You should take courses in--

- machine shop
- mechanical drawing
- blueprint reading
- electronics
- shop mathematics
- algebra
- geometry
- physics

You can continue your training after high school graduation by attending a two-year technical school. Or you may want to enter an apprenticeship program.

An apprenticeship program probably will last four years. As an apprentice, you will receive on-the-job training and classroom instruction.

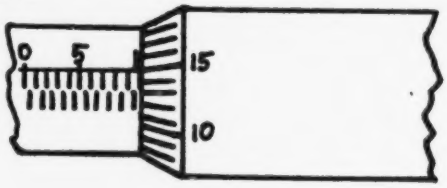
Taking every chance to learn new skills and tasks will help you get a better job and a higher salary. Showing that you have math skills will also help.

DO YOU WANT TO DO MORE MAINTENANCE MECHANIC'S MATH?

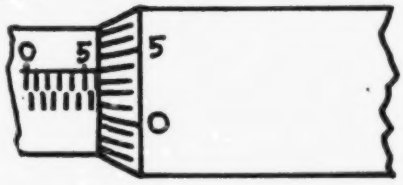
Practice Exercise E

What is the measurement on each metric micrometer below?

26.



27.



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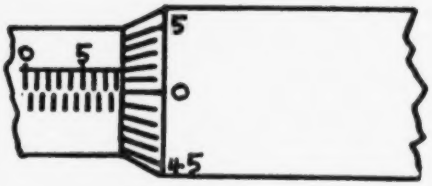

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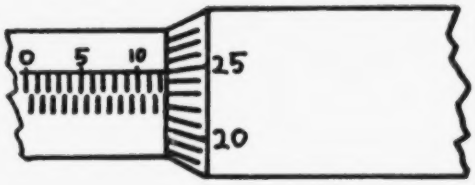

Practice Exercise F

Use this conversion table to complete problems 30-35.

English		Metric
1 in.		= 2.54 centimeters (cm)
1 ft.		= 30.5 centimeters (cm)
1 yd.		= 91.4 centimeters (cm)
1 mile		= 1610 meters (m)
.0394 in.		= 1 millimeter (mm)
3.28 ft.		= 1 meter (m)

30. 12 in. = ? cm
31. 18 ft. = ? cm
32. 6 yd. = ? cm
33. 3 miles = ? m
34. 20 in. = ? mm
35. 328 ft. = ? m

Practice Exercise G

Copy and complete the table below.

	Pulley A		Pulley B	
	Diameter	rpm	Diameter	rpm
36.	42	96	84	?
37.	16	?	20	44
38.	60	120	70	?
39.	?	50	20	100
40.	16	78	?	210
41.	?	45	15	180
42.	17	?	68	225
43.	7	21	?	63

Practice Exercise H

Copy and complete the table below.

	Gear A		Gear B	
	Number of Teeth	rpm	Number of Teeth	rpm
44.	22	10	?	20
45.	128	?	64	45
46.	230	100	160	?
47.	?	31	94	62
48.	280	90	?	56
49.	34	?	68	50
50.	62	31	104	?

DO YOU WANT TO EXPLORE SOME MORE?

1. See if you can help repair something around your home, such as a car, lawnmower, washing machine, or clothes dryer. Do you like doing this type of work? Are you able to do the work easily? Would you like to do this type of work all the time?

2. Talk to your guidance counselor about your interest in becoming a maintenance mechanic. Ask about apprentice and on-the-job training programs. Ask about the length of training, classroom instruction, and future job possibilities.

3. Are you interested in other jobs that maintain and repair machinery?

   - **Diesel engine mechanics** maintain and repair diesel engines in trucks, buses, and other vehicles.
   - **Millwrights** install and remove industrial machinery and equipment.
   - **Aircraft mechanics** maintain and repair aircraft engines and parts.
   - **Tool and die makers** make machines and machine parts.
   - **Machine assemblers** put together machines.
   - **Air-conditioning and refrigeration mechanics** install and service air-conditioning and refrigeration systems.

   You must have good math skills to do these jobs well. Most of these workers add, subtract, multiply, and divide every day on the job.

GLOSSARY

Asterisk (*): a mark that tells you to look at the bottom of the page for the meaning, or definition, of the word.

Blueprints: a hand-drawn picture of how something is made or built.

Calipers: instruments with two legs or pieces that can be adjusted to determine thickness, diameter, and distance.

Glossary: a list of words with their meanings.

Micrometers: instruments used to make small, precise measurements.

ANSWER SHEET

Practice Exercise A

1. 12.05 millimeters
2. 5.26 millimeters
3. 4.68 millimeters
4. 7.70 millimeters

Practice Exercise B

5. 18.91 in.
6. 548.4 in.
7. 131.98 in.
8. 7.93 m
9. 334.56 ft.
10. 3.27 in.

Practice Exercise C

11. 480 rpm
12. 5.67 in.
13. 41 rpm
14. 144 in.
15. 96 rpm
16. 20 in.
17. 9 in.
18. 35.53 in.

Practice Exercise D

19. 96 rpm
20. 140 teeth
21. 20 teeth
22. 80.5 rpm
23. 38.2 rpm
24. 30 rpm
25. 50 teeth

Practice Exercise E

26. 10.15 millimeters
27. 6.04 millimeters
28. 8.52 millimeters
29. 12.75 millimeters

Practice Exercise F

30. 30.48 cm
31. 549 cm
32. 548.4 cm
33. 4830 m
34. 50.76 mm
35. 100 m

Practice Exercise G

36. 48 rpm
37. 55 rpm
38. 102.86 rpm
39. 40 in.
40. 5.94 in.
41. 60 in.
42. 900 rpm
43. 2.33 in.

Practice Exercise H

44. 11 teeth
45. 22.5 rpm
46. 143.75 rpm
47. 188 teeth
48. 450 teeth
49. 100 rpm
50. 52 rpm